

NEW PUBLICATIONS.

THE DEPTHS OF THE SEA.

THE DEPTHS OF THE SEA. By C. WYLLIE THOMSON. Pp. 327. Macmillan & Co.

The purpose of this volume is to present a popular account of the results of the Deep-sea Dredging Expeditions, which were undertaken by the British Admiralty at the instance of the Royal Society in the years 1868-70. The author, who is Professor of Natural History in the University of Edinburgh, was deputed by the other members of the Expedition to prepare the account, in addition to the official reports that have been published in another form, and he has admirably performed his task by the production of a work of no less popular interest than scientific value.

The first expedition was made in the Summer of 1868 in a small Government vessel, the gunboat Lightning, which had been placed by the Admiralty at the disposal of Dr. W. B. Carpenter and the author. It was decided to make the trial cruise to the north of Scotland, and for that purpose, the Lightning left Pembroke, August 4, 1868, and arrived at the Faroe Banks after a voyage of about ten days. They remained in the harbor of Thorshavn, the capital of Faroe, until the 20th of August, the weather being so bad as to make all outside work impossible. The first days of September were more moderate, enabling the explorers to dredge at a depth of 500 fathoms with a bottom temperature a little below the freezing-point. Here they found an abundance and variety of animal life. The bottom was covered with small rounded pebbles, and sticking to them large and rare specimens of many invertebrate groups, among them a magnificent new star-fish of singularly curious structure. After several discoveries of interesting forms of animal life, the Expedition started to return to Pembroke, Sept. 24, but on account of stress of weather and an accident to the vessel, was obliged the next day to come to anchor in the harbor of Holyhead. The results of this cruise were as satisfactory as had been anticipated, although the weather was unusually severe. During the six weeks of service only ten days were available for dredging in the open sea, and on four of these only was the water over 500 fathoms deep. But it was shown beyond question that animal life was profusely represented by all the invertebrate groups at depths in the ocean down to at least 600 fathoms, in spite of the peculiar conditions to which animals are there exposed. It was also shown that the temperature of the sea instead of being uniform at certain depths was subject to constant variations from the action of currents, and that great masses of water at different temperatures are moving about, each in its particular course, forming a remarkable system of oceanic circulation, and yet so distinct from one another that an hour's sail may be sufficient to pass from the extreme of heat to the extreme of cold. Not less important was the fact disclosed by the Expedition that a large proportion of the forms living at great depths in the sea belong to species hitherto unknown, and that a new field of boundless extent and great interest is open to the naturalist.

The next Expedition to which the Porcupine, a government surveying vessel, had been assigned, commenced on the 18th of May, and ended on the 13th of July, 1869, extending along the Atlantic coasts of Ireland and Scotland to the distance of about 450 miles from Cape Clear to Rockall. The first dredging was made about 40 miles off Valentia in 110 fathoms of water, with a bottom of mud and sand. The results of this dredging gave an idea of the fauna at that depth on the west coast of Ireland. Proceeding southward, as the weather was very rough they dredged in shallow water in Donegal Bay, and the next week, with improving weather between Valentia and Galway at depths varying from 80 to 808 fathoms. The general character of the fauna was what is commonly regarded as northern. On arriving at Rockall, the weather became fine, and the dredging was pursued for several days at a depth of more than 1,200 fathoms. The greatest depth achieved was 1,376 fathoms, and the whole result of the cruise was an abundance of novel and interesting varieties in every department of the invertebrates. The conditions at that great depth at least were consistent with the life of all the types of marine invertebrates, though undoubtedly the number of species of the higher groups was greatly reduced, and in many cases the individuals appeared to be dwarfed. It was natural to conclude from this that no depth of the ocean was so great as to preclude the existence of animal life. Still the question was not thoroughly settled. It was accordingly decided to make the attempt in the deepest soundings within reach. This was found to be 2,500 fathoms, about 350 miles west of Ushant. The deepest soundings thus far that can be depended on do not reach to a much greater depth than 3,000 fathoms. It was hence argued that if the existence of life and its conditions could be determined with accuracy down to 2,500 fathoms, the general question would be virtually solved for all depths of the ocean, and any further investigation of its deeper abysses would be mere matter of curiosity and of detail.

The Porcupine accordingly started from Belfast on a second cruise, with this purpose in view, on July 17. The weather was favorable, and in less than a week they obtained soundings of 2,435 fathoms. The dredge dipped deeply into the soft gray chalk mud, and brought up a quantity of paste with but a small proportion of fresh shells. On careful sifting, the ooze was found to contain fresh examples of each of the invertebrate sub-kingdoms. Although none of these were actually living when they were examined a few hours after they had been placed on deck, their soft parts were perfectly fresh, and there was ample evidence of their having been alive when they entered the dredge. The remainder of the voyage was rewarded with similar results, and they returned to Queenstown on July 31. Another cruise was made during the month of August and the early part of September, in the channel between Faroe and Shetland, with very gratifying success.

In the Spring of 1870, it was decided that the deep sea explorations should be extended to the south of Europe and the Mediterranean, and after a preliminary cruise under the scientific direction of Mr. Gwyn Jeffreys, Dr. Carpenter took charge of the expedition on Aug. 6, and soon after steamed out into the middle of the Straits of Gibraltar, for the purpose of commencing a series of observations on the currents. The first sounding in the basin of the Mediterranean was taken on Aug. 16, at a depth of 166 fathoms, with a bottom of dark gray mud. The dredge was set down at successive stations with indifferent results, leading Dr. Carpenter to conclude that the bottom of the Mediterranean at depths beyond a few hundred fathoms is nearly destitute of animal life. Near the African coast, the fauna was more abundant, but the bottom was so rough that it was unsafe to use the dredge. Many corals, sponges, and other specimens were taken, but they were mostly well-known Mediterranean species. After a short stay at Malta, they passed along the Sicilian coast, returning to Gibraltar on Sept. 28, when Dr. Carpenter resumed his experiments on the currents of the Strait, and finally returned to England on the 8th of October.

The discoveries made by these expeditions have resulted in a vast accession to our knowledge of marine zoology. Until a few years past, nothing had been ascertained with certainty concerning the character of the ocean depths. It was the popular idea that they were wholly incapable of sustaining animal life. Men conceived of them as a desolate waste, shrouded in eternal darkness, and subjected to a stupendous pressure as to make life of any kind impossible. Even men of science shared in the prevalent idea. They were unwilling to accept the instances of animals, comparatively high in the scale of life, that were reported to have been brought up on sounding lines from great depths. The great ocean slumbered beneath the moon, covering a region apparently inaccessible to human research and experiment. Dr. Carpenter and his colleagues, however, found that it was possible to work with as much certainty, if not with so much ease, at a depth of 600 fathoms as at 100. Their operations were carried to the depth of nearly three statute miles with perfect success. The bed of the ocean, comprising an area of 140,000,000 square miles, is now added to the

legitimate field of natural history. It is no longer a barren waste, but a nursery of rich and varied life. Its fauna in many cases exhibits a series of more elaborate and delicate organisms, of exquisite beauty in their soft shades of coloring, and the rainbow tints of their marvelous phosphorescence, far surpassing those of the shallow water that fringes the land.

The time has not yet arrived, in the opinion of the author of this volume, for a detailed account of how deep-sea fauna. He gives a general statement, however, of the fruits of the recent experiments which cannot but awaken the deepest interest in every class of readers. The bottom of the sea, once an enormous area, consists of calcareous sediment. The matter brought up by the dredge at the depth of 2,500 fathoms was chiefly a compact mortar, of a bluish color, passing into a thin superficial layer, much softer and more creamy in consistence and of a yellowish color. Under the microscope the surface layer was found to consist mainly of entire shells, large and small, with fragments of the same mixed with a quantity of shapeless calcareous matter in fine particles, a little fine sand, and a few species of sponges and other marine products. Below the surface the sediment becomes more compact, and of a slight gray color. Perfect shells almost entirely disappear, fragments become smaller, and calcareous mud, in a fine state of division, abounds in large proportion. This sediment, there can be no doubt after examination, is formed in the main by the accumulation and disintegration of certain shells, which are fresh, whole, and living in the surface of the deposit, but in the lower layers dead, gradually crumbling down by the decomposition of their organic cement, and the pressure of the layers above—an animal formation not unlike that of the accumulation of vegetable matter in a peat-bog, by life and growth above, and death, retarded decomposition, and compression beneath.

In the bed of the Atlantic generally, the operation of dredging afforded evidence of a considerable quantity of soft gelatinous organic matter, giving a slight viscosity to the mud of the surface layer. It was shown by experiment that this character was capable of a certain amount of movement, and hence manifested the phenomena of a very simple form of life. This organism, if that term can be used where there is no distinction of organs, consisted apparently of a sheet of a proteine compound, irritable to a low degree and capable of assimilating food. The special interest of this peculiar formation is derived from its enormous extent. It appears to cover a large part of the bed of the ocean.

Entangled and borne along in the viscous stream of this gelatinous material is a multitude of minute calcareous bodies that were long supposed to have some mutual relation with the former. In shape they are somewhat like oval shirt-studs. They are met with in all stages of development, but their true character has not yet been determined. A vast number of other protozoa are found in the same company, but of their life history we as yet know very little.

The casts of the dredge in deep water teach us that our knowledge of sponges is in its infancy. Those which we have collected from shallow water along our shores, or which have been brought up from deep water on fishing-lines, have surprised us by the beauty of their forms and the delicacy of their structure, but they are the mere margin and remnant of a wonderful sponge-fauna that appears to extend in endless variety over the whole of the bottom of the sea. An exquisite sponge was found by Mr. Gwyn Jeffreys in 451 fathoms off the mouth of the Strait of Gibraltar. The surface was formed of a network of large spicules, and the sponge was distinguished by having a delicate outer veil about a centimetre from the surface. Two specimens of another beautiful sponge were dredged by Mr. Jeffreys in 574 fathoms in rocky ground off Cape St. Vincent. The larger formed a complete vase of very elegant proportions. It came up folded together, and had the appearance of a piece of coarse, gray-colored blanket. This sponge seems to live fixed to a stone. There are no anchoring spicules, and the bottom of the case had apparently been torn from some attachment. Sponges belonging to other groups from the deep sea were no less interesting. Near the mouth of the Strait of Gibraltar a number of species were taken in considerable quantity, forming a beautiful continuous network of sili, taking the appearance of delicate lace when held in nitric acid.

The services rendered to science in our own country by the Coast Survey, and especially by Count de Pourtales, one of its officers, are referred to by the author in terms of high and deserved commendation. In the year 1868, M. de Pourtales commenced a series of deep-dredgings along the Gulf Stream off the coast of Florida, which were continued in the following year, and which were "productive of most valuable results." Many important memoirs from his hand have greatly enriched the pages of different scientific periodicals, and added much to our knowledge of the deep-sea Gulf-Stream fauna, as well as of the nature of the bottom in those waters.

The progress of marine zoology is related at length in one of the most interesting portions of the volume. The first person who undertook the study of that science with special reference to the distribution of marine animals in space and in time was the late Prof. Edward Forbes. After investigating the fauna of the British sea to the depth of 300 fathoms by dredging, he pursued his operations with great care in the Egean at depths varying from one to one hundred fathoms. He published several works of great value, giving a general outline of his views in regard to the distribution of marine forms, and their relation to the phenomena of geology. Prof. Forbes has the credit of opening the way to the discussion of these questions in a broad philosophical sense. Every new fact in the study illustrates more clearly the brilliant results that are to be attained by following his methods. With nearly all the leading naturalists of his time, Forbes was one of the most ardent believers in the immutability of species. But upon this point the author alludes to the great change of opinion which has taken place within the last ten or twelve years, due to the ability and candor with which the question has been treated by Darwin and Wallace, and to the genius of Professor Haeckel, Dr. Fritz Müller, and others of their enthusiastic disciples and commentators. The author, however, states the case too strongly in asserting "that there is now scarcely a single competent general naturalist who is not prepared to accept some form of the doctrine of evolution." An illustrious example to the contrary is found in Professor Agassiz, not to mention Chancellor Howard Crosby, or Professor Taylor Lewis.

The volume, which forms one of the most important contributions of the season to the science of physical geography, is brought out in a style of rare topographical elegance, and is copiously illustrated with admirable drawings from nature. It will fill a choice place in the library both for the interest of its contents and the beauty of its execution.

THE ROMANCE OF ASTRONOMY. By R. KALEY MILLER, M. A. 12mo. pp. 146. Macmillan & Co.

In the opening of this attractive volume, the author excuses the apparent contradiction in the title, as if there could be no more of romance in astronomy than there is "of poetic fire in Martin Tupper, or of charity in a Saturday Reviewer," on the ground of the beauty and grandeur of the phenomena which are revealed to the student of the science. It is the function of astronomy to fathom the infinite and reckon up the eternal; it pierces the abysses of space; it grasps the orb which we now see by the light that left it eighty thousand years ago; it measures its distance and traces its movements; the sun which accompanied such marvels as these must furnish episodes of a character as wonderful and as truly romantic as can be found within the airy realms of fiction or of poetry. Among the topics which the author selects from the vast field of inquiry are the planets, the moon, the sun, the comets, the stars, the nebulae, all of which he treats with a glow of enthusiasm, and a firm grasp of the imagination, while the intellect is fully satisfied by the thoroughness and accuracy of his explanations. The chapter on the sun is one of peculiar interest. After explaining the most recent theory with regard to the origin of solar heat, the author impressively descends on the fact that the sun himself is subject to the great law of mortality which pervades the material universe:

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"The fact, now placed beyond doubt, that the sun's heat is gradually wasting away, naturally leads us to cast a glance into the future. Far, very far, distant the time must be; long before it comes, in all probability, the sun itself will have been cooled together as a scroll, and the old heavens and the old earth will have passed away. But if the sun's heat system be spared long enough, the day may come when the sun with age has become weak and used up without having shewn abroad his light and heat; he has finally exhausted all his stores. He has still power, aided by the resisting medium, to drag his satellites one by one down upon his surface; and the shock of each successive impact will, for a brief period, give him a fresh tenure of life. When the earth crashes into the sun, it will supply him with a store of heat for nearly a century, while Jupiter's larger mass will extend the period by thirty thousand years. But when the last of the planets is swallowed up, the sun's energies will rapidly decline, and a deep and deadly gloom, rather than nature's grave, looking into the abyss of a future eternity, we can see nothing but a cold and burnt-out mass remaining of that glorious orb, which went forth in the morning of time, joyful as a bridegroom from his chamber, and rejoicing as a strong man to run a race."

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